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be relieved and how the student's horizon can be widened by occasional references to other methods and formulas, as well as by slight historical excursions now and then. The presentation of the triangle-solutions, both plane and spherical, is carried out well; the pupil will learn how to conduct his work neatly and economically by studying the typical solutions of the text.

So much for the essential contents of this little volume. A rather advanced chapter on inverse notation and functions is inserted immediately after the addition-formulas; the average student will not master this, but it is there if needed. The chapter on De Moivre's theorem concerns itself chiefly with the n th roots of unity and of complex numbers generally, and with the development of the sine and cosine series; these are found by first getting $\sin(nx)$ from De Moivre's theorem, putting $nx = y$, and then keeping y constant while x approaches zero. There is ample authority for this method; but will it make an appeal to the beginner? The matter of roots belongs rather to algebra; a more trigonometric use of the theorem might no doubt have been made by developing the formulas given in Chrystal's *Algebra*, Vol. 2, pp. 275-278, which are moreover of great importance in trigonometric integration.

The tables at the end give the natural functions to 3 and then to 4 places; and their logarithms, as also those of the natural numbers, to 3, 4, and 5 places in succession. All these are very clear and legible, with the exception of Table IX; here the columns of difference-numbers are placed in between the vertical columns for sine, cosine, and tangent, and moreover they are placed halfway between the logarithmic numbers. Since there are no horizontal or vertical guidelines to lead the eye, a zigzag effect is produced which is very annoying to one's eyesight and patience. This ought to be corrected when the time comes for another edition.

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BOOK NOTICES.

It is now rather usual for a textbook on "Analytic Geometry" to contain a chapter on "Empirical Equations." The new *Analytic Geometry* just published by Edwin S. Crawley and Henry B. Evans of the University of Pennsylvania is no exception. It contains such a chapter of fourteen pages. This is about the usual length.

A more extensive treatment of the subject of empirical equations is to be found in the book entitled *Empirical Formulas* by Theodore R. Running, associate professor of mathematics in the University of Michigan, recently published by John Wiley and Sons as No. 19 of the series of Mathematical Monographs edited by Mansfield Merriman and Robert S. Woodward.

Doctors' theses which are not printed in mathematical periodicals are likely to be overlooked by some who would be interested in them. Two such theses submitted to the faculty of the Catholic University of America have recently

been printed in pamphlet form at Washington, D. C. They are: "On the cardioids fulfilling certain assigned conditions" (44 pages) by Sister Mary Gervase, and "On the in-and-circumscribed triangles of the plane rational quartic curve" (31 pages) by Joseph Nelson Rice.

PROBLEMS FOR SOLUTION.

SEND ALL COMMUNICATIONS ABOUT PROBLEMS AND SOLUTIONS TO B. F. FINKEL, Springfield, Mo.

2699. Proposed by ROGER E. MOORE, University of Wisconsin.

Show that if $a_k^{(r)}$ denotes the k th term of an arithmetic progression of order r , and c_k denotes the k th binomial coefficient in the expansion of $(a - b)^n$, n being a positive integer,

$$s = \sum_{k=1}^{n+1} c_k a_k^{(r)} = 0, \quad \text{if} \quad n > r.$$

2700. Proposed by ARTEMAS MARTIN, Washington, D. C.

In a factory 250 men are paid an average wage of \$15 each per week. The men are paid unequally, the wages being \$20, \$16, \$10 and \$8 per week, respectively, for different classes of work. How many are employed at each rate of pay?

NOTE. I am told that this question was set in a Civil Service Examination Paper to be worked by Arithmetic. 2,896 answers have been found. Are there any more?

2701. Proposed by EDWARD H. WORTHINGTON, University of Pennsylvania.

Find the sum of the infinite series

$$\frac{1}{5} + \frac{1 \cdot 2}{5 \cdot 7} r + \frac{1 \cdot 2 \cdot 3}{5 \cdot 7 \cdot 9} r^2 + \cdots + \frac{n!}{5 \cdot 7 \cdot 9 \cdots (2n+3)} r^{n-1} + \cdots$$

Verify your result for $r = 0$ and $r = 1$.

2702. Proposed by N. P. PANDYA, Sojitra, India.

A conic of variable eccentricity has a focus and corresponding directrix fixed. The latus rectum cuts a fixed circle in A' and B' . If A be the vertex of the conic, find the locus of the centroid of the triangle $AA'B'$.

2703. Proposed by S. A. COREY, Albia, Iowa.

Let A_1, A_2, A_3, A_4 , and $-(A_1 + A_2 + A_3 + A_4)$ be the vector sides of a pentagon, plane or gauche. Let B_1, B_2, B_3, B_4 , and $-(B_1 + B_2 + B_3 + B_4)$ be the sides of a second pentagon, where

$$B_1 = (c_1 + c_2)A_1 + (c_1 - c_2)A_3,$$

$$B_2 = (c_4 + c_3)A_4 + (c_4 - c_3)A_2,$$

$$B_3 = (c_2 + c_1)A_2 + (c_2 - c_1)A_4,$$

$$B_4 = (c_3 + c_4)A_3 + (c_3 - c_4)A_1,$$

c_1, c_2, c_3 , and c_4 being ordinary scalars.

Then, if a_r and b_s are the lengths of the sides A_r and B_s , respectively, and if $\cos A_r A_s =$ cosine of the angle included between the sides A_r and A_s , and if $\cos B_r B_s =$ cosine of the angle included between the sides B_r and B_s , prove that

$$2(c_1 c_4 + c_2 c_3)(a_1 a_4 \cos A_1 A_4 + a_2 a_3 \cos A_2 A_3) = b_1 b_2 \cos B_1 B_2 + b_3 b_4 \cos B_3 B_4.$$